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very moderate number of pages of print, are a crystallization of all the known facts. Especially may be mentioned the investigations of inequalities in the periods of these bodies. While the number of these inequalities known in Schönfeld's time amounted to only about half a dozen, Chandler has detected their existence in about eighty other stars, and has deduced the numerical laws in about fifty of them. This will indicate, in one direction only, how the labor of caring for these objects is increasing.

It would be unjust if, while alluding to these important researches, no mention were made of Mr. Chandler's ingenious and successful device of a new form of instrument for making that class of measurements of position which had previously been made by meridian instrument alone. Both the instrument and the method were novel. In the former, instead of a motion of rotation, determined mechanically by the pivots of a horizontal axis, there was substituted one about a vertical axis determined by gravitative action of an instrument resting in mercury.

As to method, instead of a vertical plane passing through the pole, which is the fundamental plane of reference for meridian instruments, there was substituted a horizontal circle. The value possessed by such an entirely different method consists in substituting a totally different sort of observation, and hence a different set of the systematic errors to which all observations are liable, so that the combined results of the two methods are likely to be freer from them than those obtained by an adherence to a single system of observation. In a memoir of 222 pages Dr. Chandler develops the theory of the instrument and method mathematically, and gives the result of its practical use in observations made with it for a year, and directed to various astronomical problems.

Although not mentioned as forming any

part of the grounds for the award of this medal, Dr. Chandler's important labors for many years upon cometary orbits are well known to astronomers. Casual mention may be especially made of his computations relative to the principal component of 1889V, and the action of Jupiter in 1886 upon it, which led to a complete transformation of its orbit; also the definite determination of the relative orbits of the several components into which the comet became separated in consequence of that disturbance.

The Trustees of the Watson Fund feel that this brilliant series of investigations is preëminently deserving of the highest recognition which can be given by the National Academy, and have therefore not hesitated in recommending the award of the medal to Dr. Chandler.

S. NEWCOMB.

B. A. GOULD.

A. HALL.

*SUMMARY OF CONCLUSIONS OF A REPORT BY
DRES. D. H. BERGEY, S. WEIR MITCHELL
AND J. S. BILLINGS UPON 'THE
COMPOSITION OF EXPIRED
AIR AND ITS EFFECTS
UPON ANIMAL LIEE.'**

1. THE results obtained in this research indicate that in air expired by healthy mice, sparrows, rabbits, guinea pigs or men there is no peculiar organic matter which is poisonous to the animals mentioned (excluding man), or which tends to produce in these animals any special form of disease. The injurious effects observed of such air appeared to be due entirely to the diminution of oxygen or the increase of carbonic acid, or to a combination of these two factors. They also make it very improbable that the minute quantity of organic

* Results of an investigation made under the provisions of the Hodgkin's Fund. Read before the National Academy of Sciences, April 16, 1895, by permission of the Secretary of the Smithsonian Institution.

matter contained in the air expired from human lungs has any deleterious influence upon men who inhale it in crowded rooms, and hence it is probably unnecessary to take this factor into account in providing for the ventilation of such rooms.

2. In ordinary quiet respiration no bacteria, epithelial scales, or particles of dead tissue are contained in the expired air. In the act of coughing or sneezing such organisms or particles may probably be thrown out.

3. The minute quantity of ammonia, or of combined nitrogen or other oxidizable matters found in the condensed moisture of human breath appears to be largely due to products of the decomposition of organic matter which is constantly going on in the mouth and pharynx. This is shown by the effects of cleansing the mouth and teeth upon the amount of such matters in the condensed moisture of the breath, and also by the differences in this respect between the air exhaled through a tracheal fistula and that expired in the usual way.

4. The air in an inhabited room, such as the hospital ward in which experiments were made, is contaminated from many sources besides the expired air of the occupants, and the most important of these contaminations are in the form of minute particles or dusts. The experiments on the air of the hospital ward, and with the moisture condensed therefrom, show that the greater part of the ammonia in the air was connected with dust particles which could be removed by a filter. They also showed that in this dust there were microorganisms, including some of the bacteria which produce inflammation and suppuration, and it is probable that these were the only really dangerous elements in this air.

5. The experiments in which animals were compelled to breathe air vitiated by the products of either their own respiration or by those of other animals, or were in-

jected with fluid condensed from expired air, gave results contrary to those reported by Hammond, by Brown-Séquard and d'Arsonval, and by Merkel; but corresponding to those reported by Dastre and Loye, Russo Gilibert and Alessi, Hofmann Wellenhof, Rauer, and other experimenters referred to in the preliminary historical sketch of this report, and make it improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals, other than carbonic acid. It must be borne in mind, however, that the results of such experiments upon animals as are referred to in this report may be applicable only in part to human beings. It does not necessarily follow that a man would not be injured by continuously living in an atmosphere containing 2 parts per 1,000 of carbonic acid and other products of respiration, of cutaneous excretion, and of putrefactive decomposition of organic matters, because it is found that a mouse, a guinea pig, or a rabbit seems to suffer no ill effects from living under such conditions for several days, weeks or months, but it does follow that the evidence which has heretofore been supposed to demonstrate the evil effects of bad ventilation upon human health should be carefully scrutinized.

6. The effects of reduction of oxygen and increase of carbonic acid, to a certain degree, appear to be the same in artificial mixtures of these gases as in air in which the change of proportion of these gases has been produced by respiration.

7. The effect of habit, which may enable an animal to live in an atmosphere in which by gradual change the proportion of oxygen has become so low and that of carbonic acid so high that a similar animal brought from fresh air into it dies almost instantly, has been observed before; but we are not aware that a continuance of this immunity produced by habit has been previously noted. The experiments reported in the

appendix show that such an immunity may either exist normally or be produced in certain mice, but that these cases are very exceptional, and it is very desirable that a special research should be made to determine, if possible, the conditions upon which such a continuance of immunity depends.

8. An excessively high or low temperature has a decided effect upon the production of asphyxia by diminution of oxygen and increase of carbonic acid. At high temperatures the respiratory centers are affected when evaporation from the skin and mucous surfaces is checked by the air being saturated with moisture; at low temperatures the consumption of oxygen increases, and the demand for it becomes more urgent. So far as the acute effects of excessively foul air at high temperatures are concerned, such, for example, as appeared in the Black Hole of Calcutta, it is probable that they are due to substantially the same causes in man as in animals.

9. The proportion of increase of carbonic acid and of diminution of oxygen, which has been found to exist in badly ventilated churches, schools, theatres or barracks, is not sufficiently great to satisfactorily account for the great discomfort which these conditions produce in many persons; and there is no evidence to show that such an amount of change in the normal proportion of these gases has any influence on the increase of disease and death rates which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The report of the Commissioners appointed to inquire into the regulations affecting the sanitary condition of the British Army, properly lays great stress upon the fact that in civilians at soldiers' ages in 24 large towns the death rate per 1000 was 11.9, while in the foot guards it was 29.4, and in the infantry of the line 17.9; and shows that this difference was mainly due to diseases of the lungs occurring in soldiers in

crowded and unventilated barracks. These observations have since been repeatedly confirmed by statistics derived from other armies, from prisons, and from the death rates of persons engaged in different occupations, and in all cases tubercular disease of the lungs and pneumonia are the diseases which are most prevalent among persons living and working in unventilated rooms, unless such persons are of the Jewish race.

But consumption and pneumonia are caused by specific bacteria, which, for the most part, gain access to the air passages by adhering to particles of dust which are inhaled, and it is probable that the greater liability to these diseases of persons living in crowded and unventilated rooms is, to a large extent, due to the special liability of such rooms to become infected with the germs of these diseases. It is by no means demonstrated as yet that the only deleterious effect which the air of crowded barracks or tenement house rooms, or of foul courts and narrow streets exerts upon the persons who breathe it, is due to the greater number of pathogenic microorganisms in such localities. It is possible that such impure atmospheres may affect the vitality and the bactericidal powers of the cells and fluids of the upper air passages with which they come in contact, and may thus predispose to infections the potential causes of which are almost everywhere present, and especially in the upper air passages and in the alimentary canal of even the healthiest persons; but of this we have as yet no scientific evidence. It is very desirable that researches should be made on this point.

10. The discomfort produced by crowded, ill-ventilated rooms in persons not accustomed to them is not due to the excess of carbonic acid, nor to bacteria, nor, in most cases, to dusts of any kind. The two great causes of such discomfort, though not the only ones, are excessive temperature and

unpleasant odors. Such rooms as those referred to are generally overheated; the bodies of the occupants, and, at night, the usual means of illumination, contributing to this result.

The results of this investigation, taken in connection with the results of other recent researches summarized in this report, indicate that some of the theories upon which modern systems of ventilation are based are either without foundation or doubtful, and that the problem of securing comfort and health in inhabited rooms requires the consideration of the best methods of preventing or disposing of dusts of various kinds, of properly regulating temperature and moisture, and of preventing the entrance of poisonous gases like carbonic oxide, derived from heating and lighting apparatus, rather than upon simply diluting the air to a certain standard of proportion of carbonic acid present. It would be very unwise to conclude, from the facts given in this report, that the standards of air supply for the ventilation of inhabited rooms, which standards are now generally accepted by sanitarians as the result of the work of Pettenkofer, De Chaumont and others, are much too large under any circumstances, or that the differences in health and vigor between those who spend the greater part of their lives in the open air of the country hills and those who live in the city slums do not depend in any way upon the differences between the atmospheres of the two localities except as regards the number and character of microorganisms.

The cause of the unpleasant, musty odor which is perceptible to most persons on passing from the outer air into a crowded, unventilated room is unknown. It may in part be due to volatile products of decomposition contained in the expired air of persons having decayed teeth, foul mouths, or certain disorders of the digestive apparatus,

and it is due in part to volatile fatty acids produced from the excretions of the skin and from clothing soiled with such excretions. It may produce nausea and other disagreeable sensations in specially susceptible persons, but most men soon become accustomed to it and cease to notice it, as they will do with regard to the odor of a smoking car or of a soap factory after they have been for some time in the place. The direct and indirect effects of odors of various kinds upon the comfort, and, perhaps also, upon the health of men are more considerable than would be indicated by any tests now known for determining the nature and quantity of the matters which give rise to them.

The remarks of Renk upon this point merit consideration.

Cases of fainting in crowded rooms usually occur in women, and are connected with defective respiratory action due to tight lacing or other causes.

Other causes of discomfort in rooms heated by furnaces or by steam are excessive dryness of the air and the presence of small quantities of carbonic oxide, of illuminating gas, and, possibly, of arsenic, derived from the coal used for heating.

AMERICAN METROLOGICAL SOCIETY.

THIS Society held its annual meeting at Columbia College, on April 22d, at 3 P. M.

The President, B. A. Gould, of Cambridge, Mass., presided. There were present, Wolcott Gibbs, of Newport, R. I.; A. A. Michelson, of the University of Chicago; T. Egleston and J. H. Van Amringe, of Columbia College; T. R. Pynchon, of Trinity College; T. C. Mendenhall, of Worcester, Mass.; George Eastbourn, of Philadelphia; J. M. McKinlay and J. K. Rees, of New York City.

President Gould made an informal ad-